



Extreme hydrologic behaviors and their impacts on river morphology in the semi-endorheic Raya Graben basin (North Ethiopia)

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Due to the occurrence of steep and degraded escarpment slopes and high rain seasonality, the hydrological regime in the Raya Graben (Ethiopia) is characterized by the occurrence of strong flash floods, making the channel morphology of the braided rivers very dynamic. In this study, the impact of the flash floods on channel width was investigated. Peak discharges were measured using crest gauges at calibrated cross-sections (bridges near the escarpment footslope) in the rainy season (July and August) of 2013. In order to investigate the changes in channel morphology along the river, 15 monitoring sites were established on the Hara and the Etu Rivers, downstream from the hydrological stations. The changes in river channel width after peak flow events were measured after every major event. A linear regression analysis revealed that the increase in channel width was more important towards the end of the rainy season ($R^2=0.91$, $p<0.05$ for Hara River and $R^2=0.93$, $p<0.05$ for Etu River). Per cross-section, there was on average 2.11 m channel width change in Hara River (for 22 flash flood events) and 0.74 m in Etu River (for 13 flash flood events). The change in channel width did not show a significant relationship with distance from the escarpment footslope. The more pronounced channel widening towards the end of the rainy season is probably due to the clear water effect in relation to better vegetation cover on the escarpment that prevents sediment from being washed to the river. Because the widening of the channel highly impacts primarily farming activities, more attention should be given to the impacts of flashy floods on the channel width of dryland braided rivers.